

Chapter 3

Standard Control Loops

3-1. General

The standard control loops described in this chapter consist of control-system equipment and devices, arranged to perform specific control-system functions. In the ensuing discussions of the different types of control loops, all loop devices (including transmitters) are shown, and their associated indicators (such as thermometers) are included where required. The sensing elements are included with the transmitters and are not shown separately. Signals from the transmitters represent the changing conditions at the sensing elements. Also, the required panel-mounted and field-mounted pneumatic indicators are shown. Modulating-control signals from controllers are converted from 4-20 milliamperes to 3-15 psig by a current-to-pneumatic transducer (IP) connected to a positive positioner (PP) of a valve or damper actuator as applicable.

3-2. Cooling-coil-temperature control loop

a. The cooling-coil-temperature control loop is a constant-temperature control loop and is shown in figure 3-1. Temperature-sensing element and transmitter TT sends a temperature signal to controller TC, which modulates an IP. The pneumatic signal from the IP is connected to positive-positioner PP, which operates cooling-coil valve VLV. The conditions that must be operative for the control valve to be controlled are: the supply fan is on and the control system is in the occupied mode.

b. A relay contact between TC and IF is open when either constraint is operative.

3-3 Outside-air preheat-coil-temperature control loop

a. When the mixed-air temperature of the outside air and the return air is too low, a preheat coil will be used to heat the outside air. This modulating-control loop will be used only with hot-water or hot-glycol heating units. A variation of the preheat-coil control loop for use with steam preheat coils is shown in chapter 5. The purpose of raising the mixed-air temperature is to prevent freezing of chilled-water coils and hot-water coils downstream of the mixed-air plenum. The coil is sized to raise the temperature of the maximum design quantity of outside air just high enough to bring the mixed-air temperature within the range of 45 to 50 degrees F. The loop controls the temperature of the air leaving the preheat coil before the air mixes with return air. The setpoint of the controller of this loop is the HVAC system designer's calculation of the coil-discharge-air temperature required to maintain a minimum temperature in the mixed-air plenum when the outside-air is at the coldest temperature. This setpoint assures an adequate minimum temperature entering the cooling coil of an HVAC system. The outside-air preheat-coil-temperature control loop is shown in figure 3-2.

b. A temperature-sensing element and transmitter TT, in the discharge-air stream from the preheat coil, sends a temperature signal to preheat-coil temperature controller TC. Controller TC operates transducer IF to maintain the

setpoint of the controller by modulating a valve VLV. Since the TC setpoint is normally in the range of 40 to 55 degrees F, the valve is controlled during the heating season when the outside-air temperature is below the TC setpoint. When the outside-air temperature is at or above the TC setpoint, VLV is closed.

c. In this control loop, TC is direct-acting DIR, and VLV is normally open (NO) and fails open under the pressure of the valve actuator's return spring on loss of electric signal, pneumatic signal, or positive positioner air supply. The purpose of this is to avoid freezing of the preheat coil and other coils in the HVAC system should such an event occur in cold weather.

d. The preheat-coil control loop functions continuously, without regard to the operating condition of the HVAC system. This has the advantage of maintaining a minimum temperature in the ductwork when the HVAC system supply fan is off.

3-4. Heating-coil-temperature control loop

a. When they are not sequenced with cooling coils, heating coils of HVAC systems are controlled by either of the following methods:

(1) Controller setpoint scheduled from outside-air temperature.

(2) Controller setpoint fixed.

b. Control via the setpoint scheduled from the outside-air temperature occurs with the greater frequency. Figure 3-3 shows the heating-coil-temperature control loop scheduled from outside-air temperature for the purpose of conserving energy. This loop is shown as it is used to control heating coils for multizone HVAC systems or dual-duct HVAC systems. If a preheat coil is used in the design of the HVAC system, the temperature-sensing element in the outside air must be located upstream of the preheat coil. Controllers TC REV and TC DIR receive temperature-transmitter input signals with differing calibrated input ranges as shown. Temperature-sensing element and transmitter TT in the outside-air intake of the HVAC-system sends a signal to process-variable input PV of controller TC REV. Controller TC REV also reverses its output signal relative to the outside-air-temperature transmitter signal. The signal reversing is necessary because the setpoint of TC DIR must change in the opposite direction from that of change in outside-air temperature. Controller TC DIR operates heating-coil valve VLV. Temperature-sensing element and transmitter TT in the coil-discharge air sends a signal to process-variable input PV of TC DIR. Temperature-sensing element and transmitter TT in the outside-air intake signals TC REV, to raise the TC DIR setpoint when the outside-air temperature decreases and to gradually lower the TC DIR setpoint, in a linear schedule, as the outside-air temperature increases. Companion thermometers are shown where required. The limits of the control point adjustment (remote setpoint input) (CPA), to prevent the temperature schedule from exceeding 120 degrees F or decreasing below 90 degrees F, are set by limiting the maximum and minimum outputs of controller TC REV.

c. The temperature schedule (selected for illustration) desired for the heating-coil leaving-air temperatures is 120 degrees F at 0 degrees F outside-air temperature and 90 degrees F at 60 degrees F outside-air temperature, as shown in figure 3-3.

d. In order to achieve the schedule shown in figure 3-3, certain controller parameters must be calculated for controller TC REV. Controller TC REV output is the outside-air temperature schedule input to the remote-setpoint input (CPA) of heating-coil temperature controller TC DIR. These controllers have differing calibrated input ranges. The output of TC REV at 0 degrees F and 60 degrees F must match the input required to set TC DIR to 120 degrees F and 90 degrees F, respectively. The panameters for TC REV which match the output of TC REV to the required CPA reset range of TC DIR and the input range of its input transmitter are: the controller proportional band, the setpoint, and the minimum and maximum output settings. The output of TC REV must set TC DIR to a temperature setpoint of 120 degrees F when the outside-air temperature is 0 degrees F, and set TC DIR to a temperature setpoint of 90 degrees F when the outside-air temperature is 60 degrees F. These points define a line on a coordinate system of outside-air temperature as the abscissa and discharge-air temperature as the ordinate. All points on this line can be found by the use of equation 3-1.

$$y = mx + b \quad (\text{eq.3-1})$$

Where:

- y = ordinate (discharge-air temperature).
- m = slope of line between points on the line.
- x = abscissa (outside-air temperature).
- b the y-axis intercept.

The slope of the line (m) connecting the abscissa points of 0 degrees F and 60 degrees F outside-air temperature and the ordinates of 120 degrees F and 90 degrees F discharge-air temperature is found to be minus 0.5 [(120-90)/(0-60)]. The value of the y-axis intercept (b) is found by setting the value of x at 0 degrees F, and is found by equation 3-1 to be 120 degrees F. The required throttling range of TC REV is found by using equation 3-1 and setting the value of y at the extremes of the calibrated input range of TC DIR. On the lower end of range of TC DIR, the value of y is calculated to be 160 degrees F, and the value of y at the upper end of the range is calculated to be minus 40 degrees F. From these calculated values, the temperatures span of the throttling range of TC REV is calculated as 200 degrees F [160 - (-40) = 200]. Because the setpoint must be at the midpoint of a 200 degree F throttling range extending from minus 40 degrees F to 160 degrees F, the setpoint of TC REV is calculated to be 60 degrees F [-40 + 200/2 = 60 or 160 - 200/2 = 60]. Use of equation 2-1 to calculate the proportional band setting results in a value of 125 percent proportional band (PB - 200/160 x 100 percent) when 200 degrees F is used as the portion of the span required for the throttling range and 160 degrees F is the transmitter span. Because the span of the throttling range exceeds the span of the transmitter, the proportional

band is greater than 100 percent. This means that the output of TC REV is limited by the limits of its input transmitter values. Discharge-air-temperature setpoints beyond those shown for minus 30 degrees F and 130 degrees F. outside-air temperature cannot be scheduled in this example. The output of controller TC REV cannot achieve a full-scale change because of the combination of the proportional-band setting and the calibrated input range of TC REV, which must match that of the outside-air temperature transmitter. The schedule of discharge-air temperatures can be further limited by setting the minimum and maximum output limits of TC REV. The controller's maximum output setting is calculated to be 80 percent [(160-0) degrees F/160 - (-40) degrees f x 100 percent = 80 percent]. The controller's minimum output setting is calculated to be 50 percent [(160-60) degrees F/[160-(-40)] degrees F x 100 percent = 50 percent]. Using the calculated values for proportional band, setpoint minimum output and maximum output will result in a controller input/output schedule as shown in figure 34, which shows the output of TT, OA for every 10 degree F change represented by a change of 1 ma [(20-4) ma/160 degrees F x 10 degrees F = 1 ma], and the input of TC DIR for every 5 degrees F represented by a change of 0.8 ma [(20-4) ma/100 degrees F x 5 degrees F = 0.8 ma].

e. The heating-coil temperature-control loop, with its fixed-controller setpoints, is similar to the preheat-coil-temperature control loop in that it also controls the coil valve at all times. Figure 3-5 shows the heating coil controlled in a fixed-temperature application. Temperature-sensing element and transmitter TT sends a signal to heating-coil temperature controller TC. The operations of the control devices affected by the output signal of TC are identical, as previously described in paragraph 3-3b.

f. The heating-coil-temperature control loop functions continuously, without regard to the operating condition of the HVAC system. This has the advantage of maintaining a minimum temperature in the ductwork when the HVAC-system supply fan is off.

3-5. Mixed-air-temperature and economizer control loops

a. The mixed-air-temperature and economizer control loops are shown in figure 3-6. The actuators on the dampers operate like the actuator on a control valve. The outside-air damper and relief-air damper are normally closed and operate in parallel with each other. the return-air damper is normally open and works opposite to the outside-air and relief-air dampers. The mixed-air-temperature control loop is linked to the economizer-control logic.

b. Outside air will not be used when the control system is in the unoccupied mode or in the ventilation-delay mode. A normally open (NO) relay contact in the circuit to IP keeps the outside-air damper closed under these conditions, and also when the supply fan is off. An open relay contact in the circuit between TC and high-signal selector TY keeps the dampers open to the manual setting of minimum-position switch MPS, when the system is in

the minimum-outside-air mode, and the outside-air damper is allowed to open by the absence of other constraints. When both of these relay contacts are closed, the control system is then operating in both the occupied and economizer modes. Controller TC maintains the mixed-air temperature by controlling the IP to modulate the dampers beyond minimum position. The signal from MPS or the signal from TC operates through high-signal selector TY to operate the IP, which sends a pneumatic signal to positive-positioner PP to control the damper actuators. The output of IP to the damper-actuator positioners can be read on PIs at the panel and at the damper location. Mixed-air-temperature sensing element and transmitter TT, sends a signal to TC, which changes its output to operate the dampers between minimum outside-air position and full outside air.

c. The temperature-sensing elements and transmitters TT in both the outside-air intake and the return-air duct send temperature signals to economizer controller EC.

d. The economizer controller EC requires a setpoint for each of two contacts that determine whether the coil of the relay that puts the system in the occupied mode or unoccupied is energized or deenergized. The setpoints and switching differentials for each of the contacts are adjustable in EC. One of the contacts, configured as a PV contact, responds to the temperature-sensing element and transmitter TT in the return-air duct and prevents the economizer mode from operating when the HVAC system is heating the space that it serves. The return-air-temperature setpoint of the contact will be selected at a temperature that is below the expected cooling-season return-air temperature but higher than the expected heating-season space temperature. The other contact, configured as a deviation (DEV) contact, responds to the difference in the signals of outside-air temperature and return-air temperature. The setpoint of the DEV contact requires a calculation by the designer. The designer will indicate the return-air temperatures at which the PV contacts open and close and the temperature differences between the outside-air temperature and the return-air temperature at which the DEV contacts open and close.

e. Because of the difficulty of maintaining enthalpy-based economizer switchover hardware, the economizer-controller operation is based on dry-bulb temperature measurements rather than enthalpy measurements. The comparison of outside-air and return-air temperatures for determining the economizer switchover point is a method of control that uses local weather data for selecting an optimum dry-bulb temperature difference. An explanation of this method begins with figure 3-7.

f. The skeleton psychrometric chart shows a return-air design condition of 75 degrees F dry-bulb temperature and 50 percent relative humidity. A constant-enthalpy line drawn through this condition divides the chart into 4 regions of outside-air temperatures and outside-air relative humidities, which are:

- (1) Region A, in which temperature and enthalpy conditions are less than return-air design conditions.
- (2) Region B, in which temperature conditions are

lower but enthalpy conditions are higher than return-air design conditions.

(3) Region C, in which both temperature and enthalpy conditions are higher than the return-air design conditions.

(4) Region D, in which temperature conditions are higher but enthalpy conditions are lower than return-air design conditions.

g. Cooling energy can be saved by using outside-air for cooling when outside-air conditions are in region A. Less energy will be used in cooling outside air than in cooling return air when outside-air conditions are in region D. When outside-air conditions are in region B, the outside-air dry-bulb temperature is less than the return-air dry-bulb temperature; however, excess cooling energy would be used if more than the required minimum of outside air is used, because the enthalpy of the outside air is higher than the design return-air condition. When outside-air conditions are in region C, there is no energy saving available from the use of outside air. The designer will consult the local weather data for the nearest location of the project as published in TM 5-785. Using a Lpsycho-metric chart, the designer will use the following procedure to determine the setting of the DEV contact:

(1) Plot a constant-enthalpy line through the Lreturn-air design temperature and relative-humidity condition.

(2) Plot an average-weather line by using midpoint of the 5 degree Fahrenheit bin and the mean coincident wet-bulb temperature for that temperature bin from TM 5-785.

(3) Read the difference in dry-bulb temperature between the design return-air temperature and the outside-air temperature where the average-weather line crosses the constant-enthalpy line.

(4) Use this difference in dry-bulb temperatures as the setting for the DEV contact.

h. An example of the application of this procedure is shown in figure 3-8.

i. Figure 3-8 illustrates the method for selection of a setpoint for the DEV contact for economizer-mode switch-over in a relatively humid southeastern United States city, based on published weather data. The method presumes that the location is such that an economizer mode is acceptable in the HVAC design because it would not place an energy burden on the system due to a requirement for humidification of more than the minimum quantity of outside air. The temperature-differential setpoint of the DEV contact is shown as 8 degrees F. However, the temperature differential determined by this method will vary with: the design return-air conditions; and the Laverage-weather line for the locality. Less-humid climates will tend to shift the average-weather line downward toward the design return-air condition, which would result in a smaller differential. The effect on energy conservation of using this method is shown in figure 3-9.

j. Figure 3-9 shows that the dry-bulb-temperature line at the intersection of the average-weather line and the constant-enthalpy line bisects region B. The area shown as region B-I represents outside-air conditions when the economizer mode will not save cooling energy even though outside air beyond the minimum quantity will be used if

the control system modulates the dampers open. The net effect on energy use depends on how many operating hours per year of the HVAC system are coincident with the occurrence of the outside-air conditions of region B-1.

3.6. Supply-duct static-pressure control loop

The supply-duct static-pressure control loop is shown in figure 3-10. A differential-pressure sensing element and transmitter (DPT) sends a signal to static pressure controller PC, which operates IP to control DA, which in turn operates fan inlet vane IV provided that the fan is on. DPT must have a relatively low range, such as 0.0 to 2.0 inches of water column. The supply fan may have been selected for a much larger static pressure, but the static pressure at the location of the DPT's sensor is typically 1.0 to 1.5 inches of water column. The sensing location of Dill' is approximately two-thirds of the distance from the supply fan along the duct calculated to have the greatest pressure drop. This sensing location insures that the static pressure will be controlled at the value required to enable all VAV boxes to function. The "Fan-On" relay contact disconnects PC from IP, causing DA to hold IV in the closed position (unloaded) on fan shutdown; the purpose in unloading the fan is to allow it to start unloaded. DPI is a low-differential-pressure gauge used as an indicator for Dill'. Details of the action of the rest of the control system devices connected to the IP's output are similar to comparable parts of other loops previously described.

3-7. Return-fan-volume control loop

The return-fan-volume control loop is shown in figure 3-11. Flow-sensing elements and linearized transmitters FTs in the supply air and the return air get signals from duct-mounted air-flow measurement stations and sensing arrays, AF MA. Both FTs send signals to controller FC. These signals are the information necessary to maintain a fixed flow difference (in cfm) between the supply-air and return-air ducts. The controller measures and controls the return-air flow through the PV input based on the supply-air flow measured at the CPA input. More than likely, the ranges of the air-flow velocities in each duct will be different because of differences in design velocity and in the cross-sectional areas of the ducts. The FTs in the supply-air duct and return-air duct may or may not have the same span and range. This means that a given flow rate in the supply duct may have a different signal level than the exact same flow rate in the return duct. In order for FC to control the return-air flow at a specific rate (cfm), the CPA signal from the supply fan FT must have the same value that will appear at PV when the set-point is achieved. To achieve this, the CPA signal from the supply duct must be converted to FC's ratio-and-bias feature to perform two functions. A ratio factor must be applied to the signal from the supply-air flow transmitter/air-flow measurement station (FT/AFMA) combination so that it will match the signal range of the return-air FT/AFMA combination. Also, the ratio is used to account for differences in the cross-sectional area of the ducts at the location of the measuring

stations. The signal must then be biased to maintain the design fixed airflow difference. For example, if the fixed difference is required to be 3,000 cfm for minimum outside-air requirements when the supply-air flow is 20,000 cfm, CPA tells FC to control PV at 17,000 cfm; when the supply-air flow is 12,500 cfm, CPA tells FC to control PV at 9,500 cfm. The 3000-cfm difference is the bias to be set in the controller in cfm units. The CPA signals at two such supply-air flow points must match the PV signals at two corresponding return-air flow points. When this is achieved at two points, the required results will be achieved for any supply-fan flow and the appropriate return-fan flows within the turndown capabilities of the return fan. The ratio can be calculated according to equation 3-2. Equation 3-2 assumes that the low end of the transmitter span is 0 fpm at 4 milliamperes for each transmitter.

$$R = (As/Ar)/(Vs/Vr) \quad (\text{eq. 3-2})$$

Where:

R = Ratio (dimensionless)

As = Area of supply-air duct at the measuring station (sq ft).

Ar = Area of return-air duct at the measuring station (sq ft).

Vs = Span of the flow transmitter in the supply duct (fpm).

Vr = Span of the flow transmitter in the return duct (fpm).

The bias is set in the controller in cfm units.

3-8. Humidifier control loop

The humidifier-control loop is shown in figure 3-12. Humidifier control-valve VLV is normally closed. It is inhibited from opening by the contact of a relay that is open unless the fan is on, the system is in the occupied mode, and the ventilation-delay period has expired. When these conditions of operation are met, space relative-humidity sensing element and transmitter RHT signals relative-humidity controller RHC to operate IP to control humidifier valve VLV. A high-limit relative-humidity controller RHC receives a signal from a duct relative-humidity sensing element and transmitter RHT downstream of the humidifier. Both controllers are reverse-acting. Low-signal selector RHV allows the space relative-humidity controller to operate the valve if the high-limit relative-humidity setpoint is not exceeded. The high-limit relative-humidity controller must be a proportional only controller.

3-9. The typical schematic

a. The integration of standard control loops into a standard system starts with a schematic. A typical schematic is shown in figure 3-13.

b. Figure 3-13 shows the control loops arranged around an airflow diagram. When showing the schematic, the designer will:

- (1) Label all HVAC equipment.
- (2) Label each control device with a unique identifier.

(3) Label the action (NC or NO) of all valves, dampers, and other appropriate devices.

(4) Label the action of all controllers as direct-acting DIR or reverse-acting REV.

(5) Label the input of all controllers (PV or CPA).

(6) For each device that operates contacts, show a line number on which each contact will appear on a ladder diagram.

(7) For each relay contact, show the line number of a ladder diagram on which the relay operating coil will appear.

(8) Show the location of all instruments not located in the flow stream or in the HVAC-control panel.

(9) Show a graphic representation of sequencing operations with open and closed positions versus controller output and space temperature.

3-10. The typical ladder diagram

a. When all the information necessary for a description of the system is now shown on the schematic, a ladder diagram will be required. A typical ladder diagram is shown in figure 3-14.

b. In the ladder diagram, the designer will:

(1) Show a section of the diagram for the HVAC control-panel logic.

(2) Show a section of the diagram for each starter-control circuit and interlock circuit for HVAC equipment.

(3) Label control devices and relays with their unique identifiers.

(4) Label magnetic-starter coils.

(5) If multiple-control devices of the same type (such as low-temperature-protection thermostats or smoke detectors) are required, assign a unique identifier for each and show its contact.

(6) Show separate relays to control AC and DC circuits.

(7) Number the ladder-diagram lines according to their control-power source.

(8) Show a switch, located in the HVAC control panel, to override the clock (or EMCS) and to be used to place the control system in continuous occupied mode (auto/auto override).

(9) Show a switch, located in the HVAC control panel, that can be used to shut down HVAC equipment and interlocked equipment (off/enable).

c. The HVAC-control-panel section of the ladder diagram will be in accordance with the following format:

(1) Line numbers will start with 0 for the clock circuit and continue as required.

(2) Control-system switches and contacts will be shown on the left of the diagram.

(3) Relay coils will be shown in the center of the diagram, centered below the clock circuit.

(4) Pilot lights will be shown on the right of the diagram.

(5) Contacts available to EMCS will be shown outside the ladder and to the right of the diagram.

d. Each section of the HVAC equipment starter-control circuits and interlock circuits will be in accordance with the

following format:

(1) The line numbers of the first section will begin with 100, the second section with 200, and subsequent sections with appropriate higher numbers in increments of one hundred.

(2) Magnetic-starter circuits will show one phase powering a control-circuit transformer, switches, fuse, and overload relays.

(3) The panel ladder diagram will have a jumper shown for connection to EMCS of an economizer enable and disable function. The panel ladder diagram will show terminal points for remote system shutdown and remote safety override control of HVAC system fans.

(4) Starter ladder diagrams will have an off-enable switch to allow HVAC system motors to be stopped from the HVAC control panel.

3-11. The typical equipment schedule

a. An equipment schedule is required to show the control-system parameters not shown on the schematic and the ladder diagram. Not all HVAC control devices shown on the schematic and the ladder diagram are included in the equipment schedule because it is not necessary to show parameters for them. Control devices that are excluded from the schematic are relays, IPs, loop repeaters, and signal selectors. A typical equipment schedule is shown in figure 3-15.

b. In the equipment schedule, the designer will:

(1) Arrange all control devices by loop function.

(2) Show the unique identifier as the device number.

(3) Name the device function.

(4) Show setpoints, ranges, time schedules, and other parameters.

(5) Show the selected Cv and required close-off pressure for each valve.

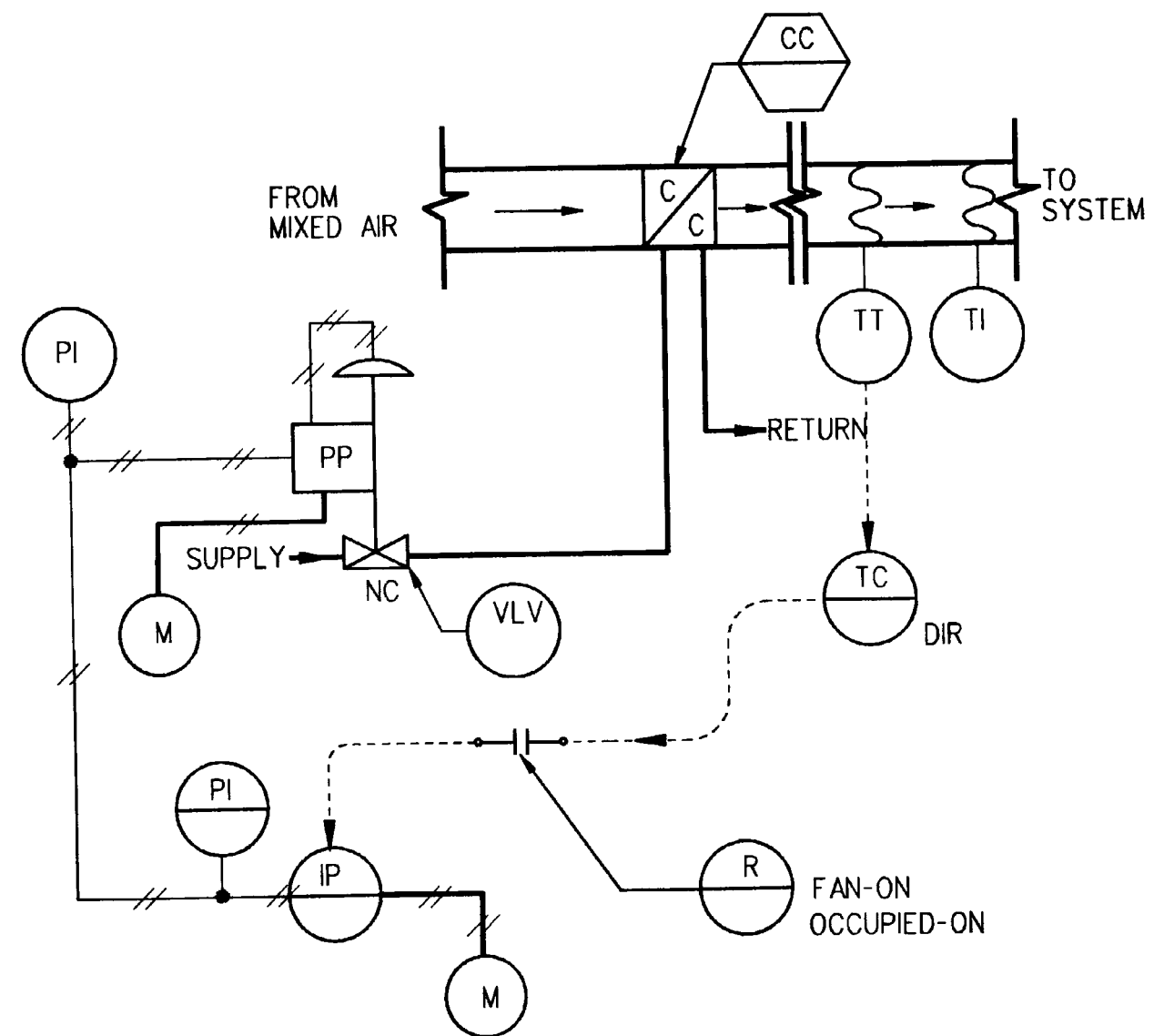


Figure 3-1. Cooling-coil temperature control loop.

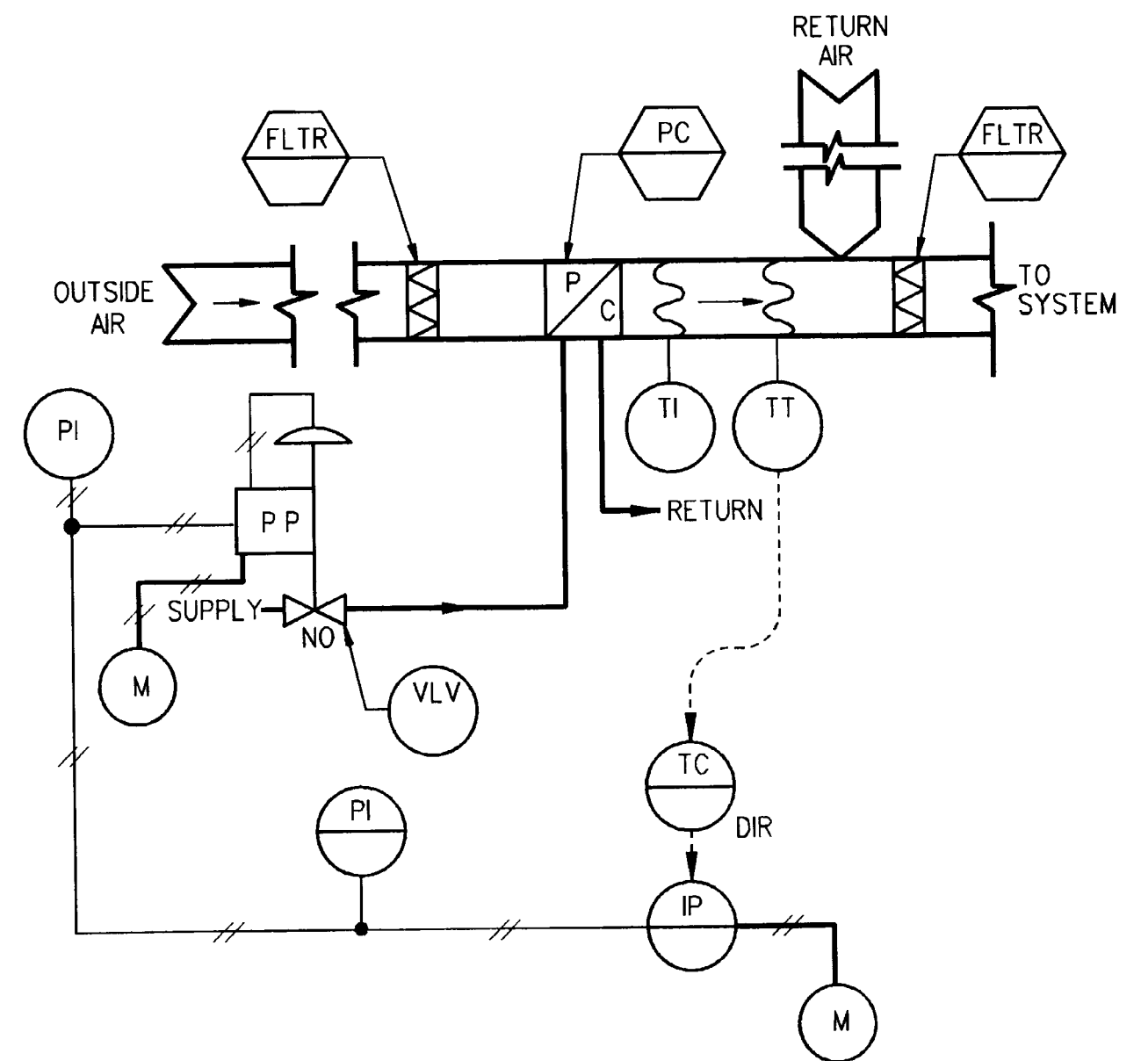


Figure 3-2. Outside-air preheat-coil-temperature control loop.

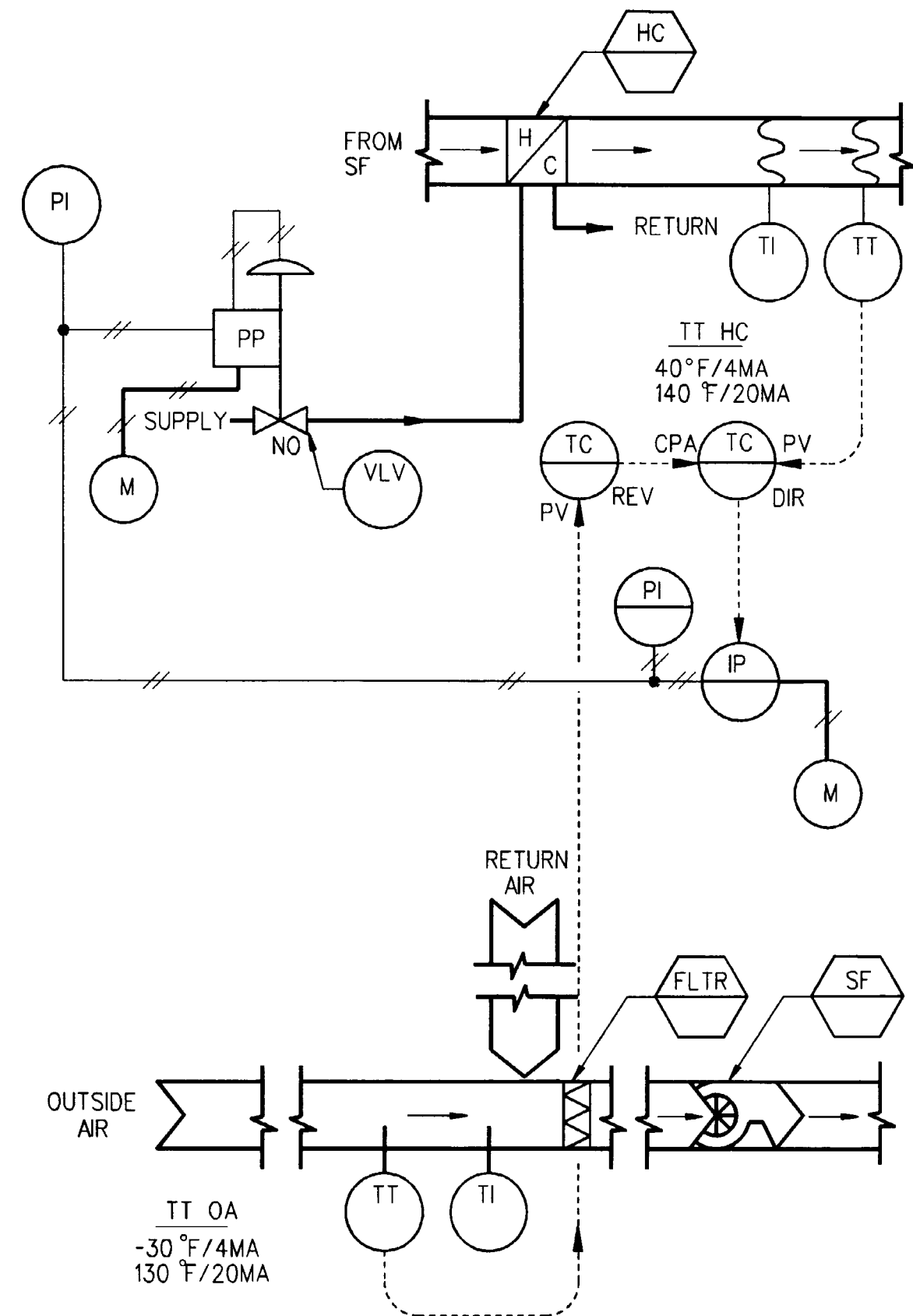
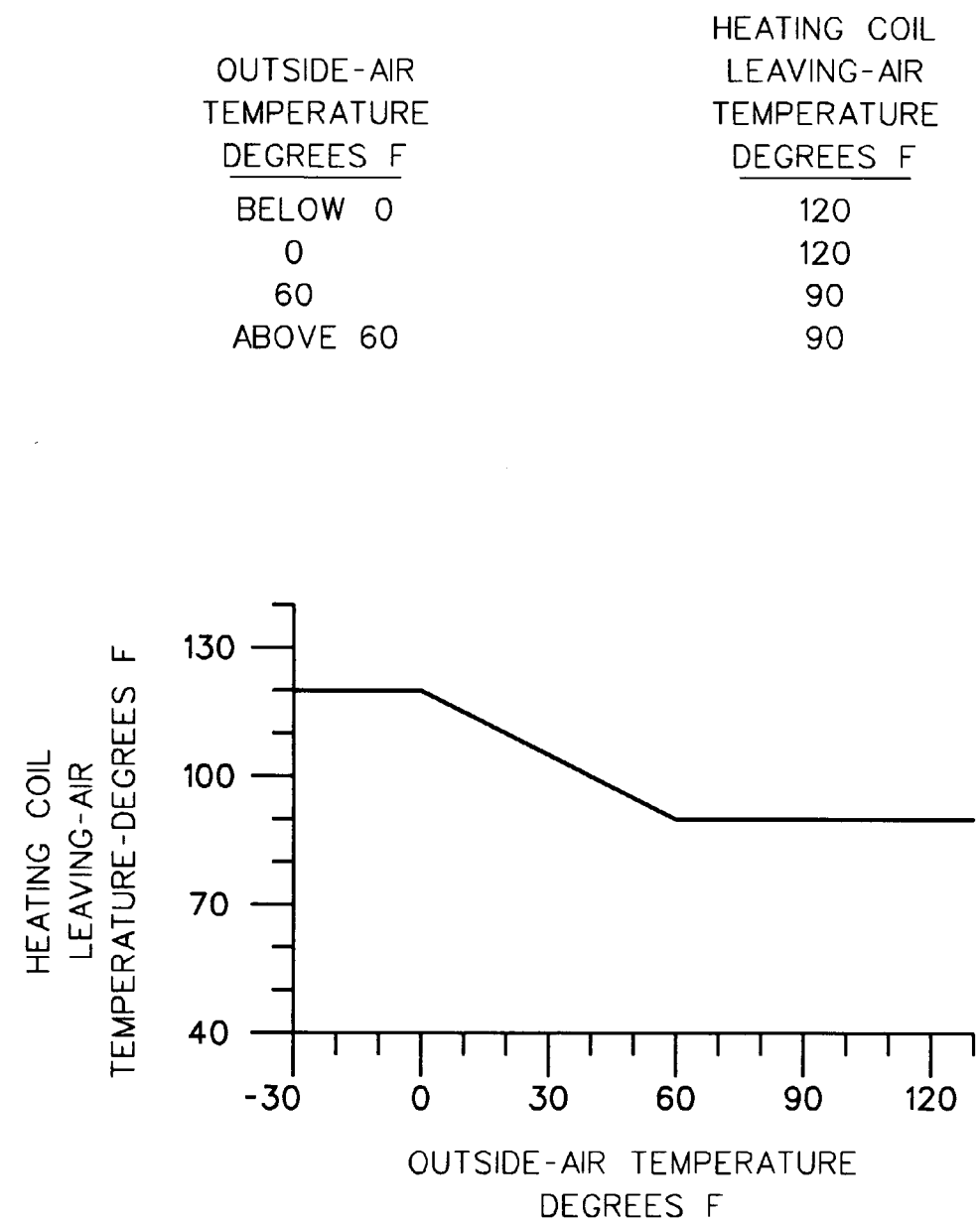


Figure 3-3. Heating-coil-temperature control loop scheduled from outside-air temperature.

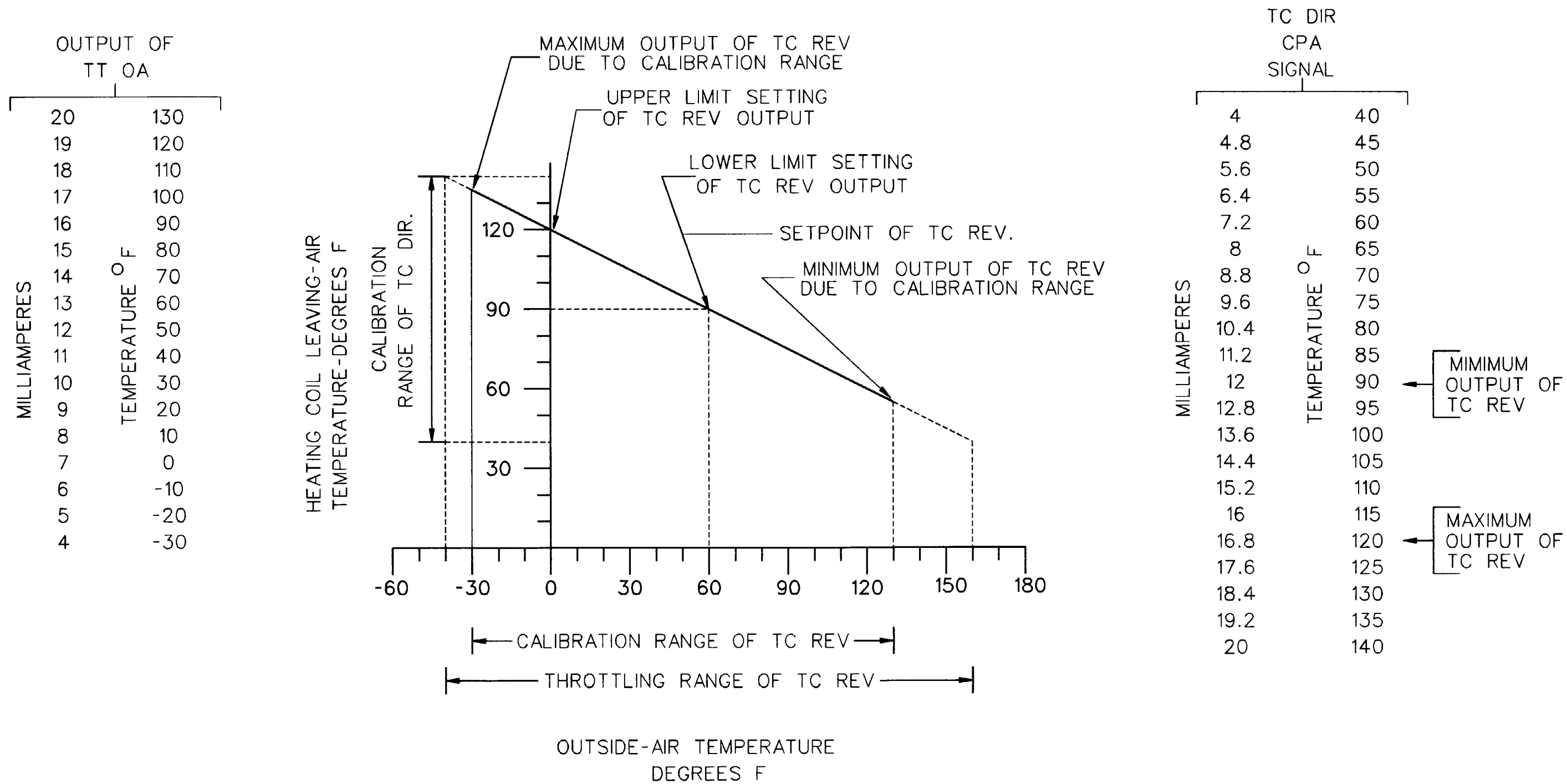


Figure 3-4. Outside-air-temperature controller input/output schedule.

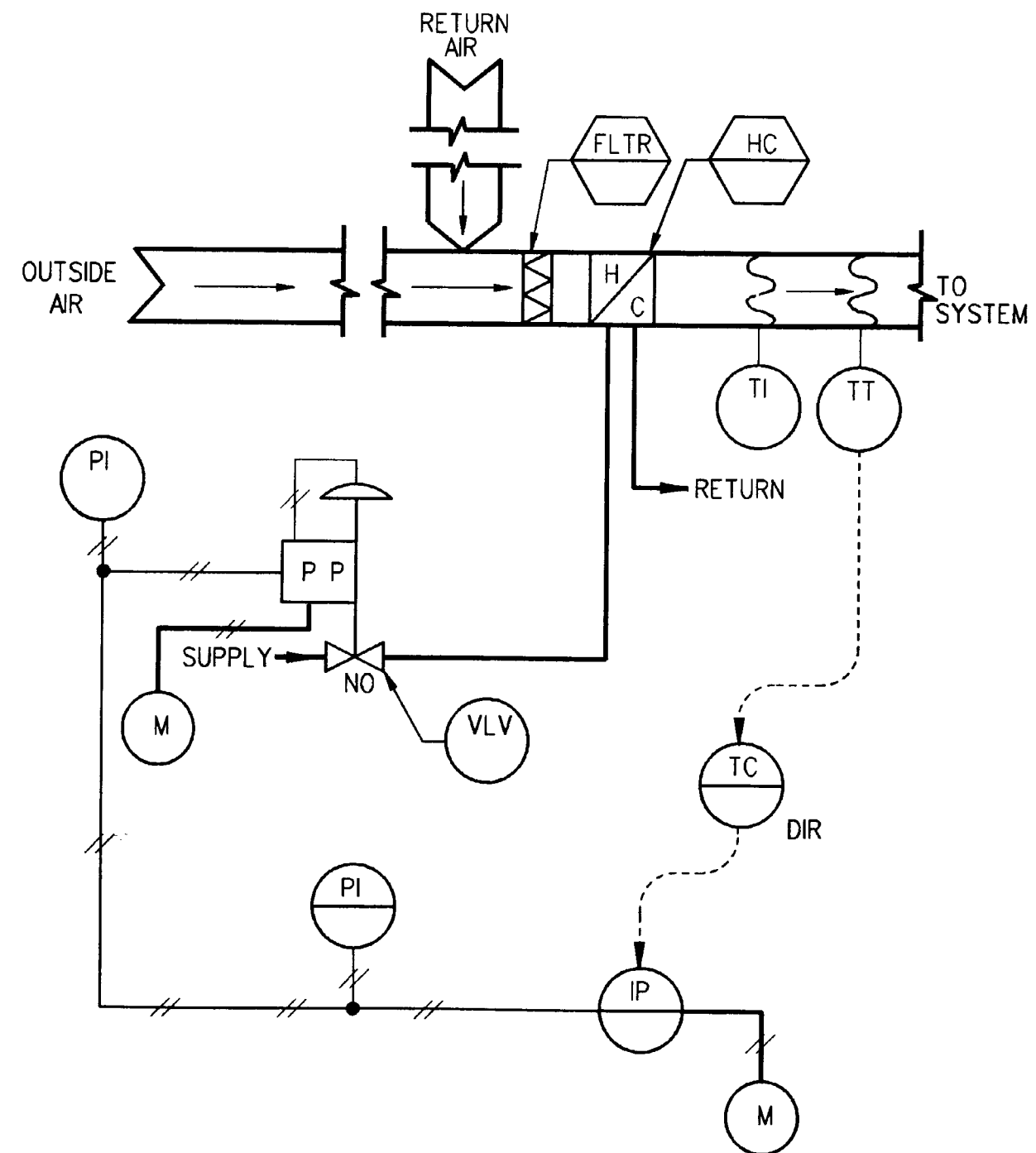


Figure 3-5. Heating-coil-temperature control loop with heating coil controlled at a constant temperature.

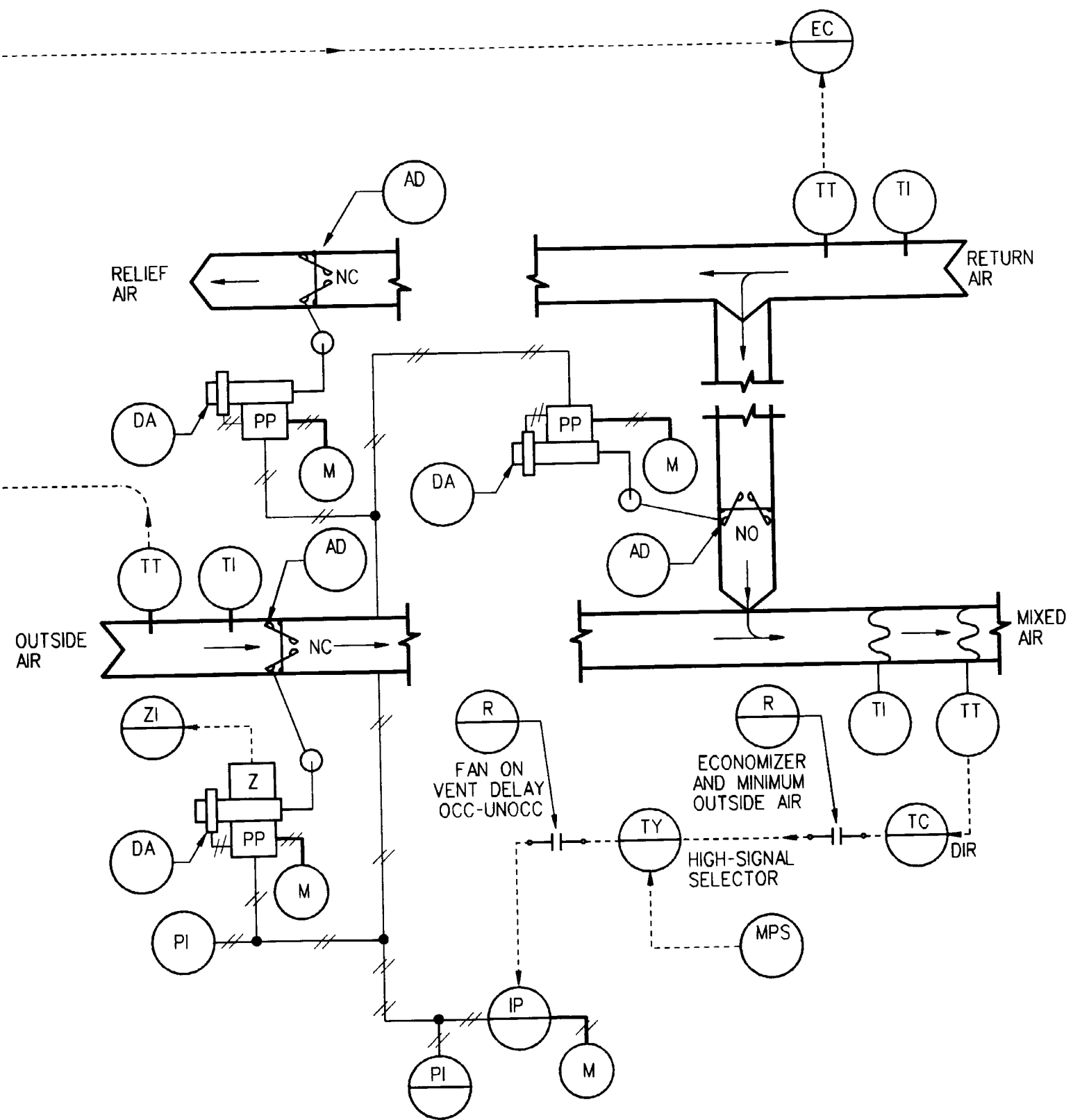


Figure 3-6. Mixed air-temperature and economized control loops.

OUTSIDE-AIR CONDITIONS	ADVANTAGEOUS OPERATING MODE	CONTROL-SYSTEM OPERATING MODE	REASONS
REGION A	ECONOMIZER	ECONOMIZER	ENTHALPY OA < ENTHALPY RA TEMPERATURE OA < TEMPERATURE RA
REGION B	MINIMUM OUTSIDE-AIR	MINIMUM OUTSIDE-AIR	ENTHALPY OA > ENTHALPY RA EVEN IF TEMPERATURE OA < TEMPERATURE RA
REGION C	MINIMUM OUTSIDE-AIR	MINIMUM OUTSIDE-AIR	ENTHALPY OA > ENTHALPY RA TEMPERATURE OA > TEMPERATURE RA
REGION D	ECONOMIZER	MINIMUM OUTSIDE-AIR	ENTHALPY OA < ENTHALPY RA EVEN IF TEMPERATURE OA > TEMPERATURE RA

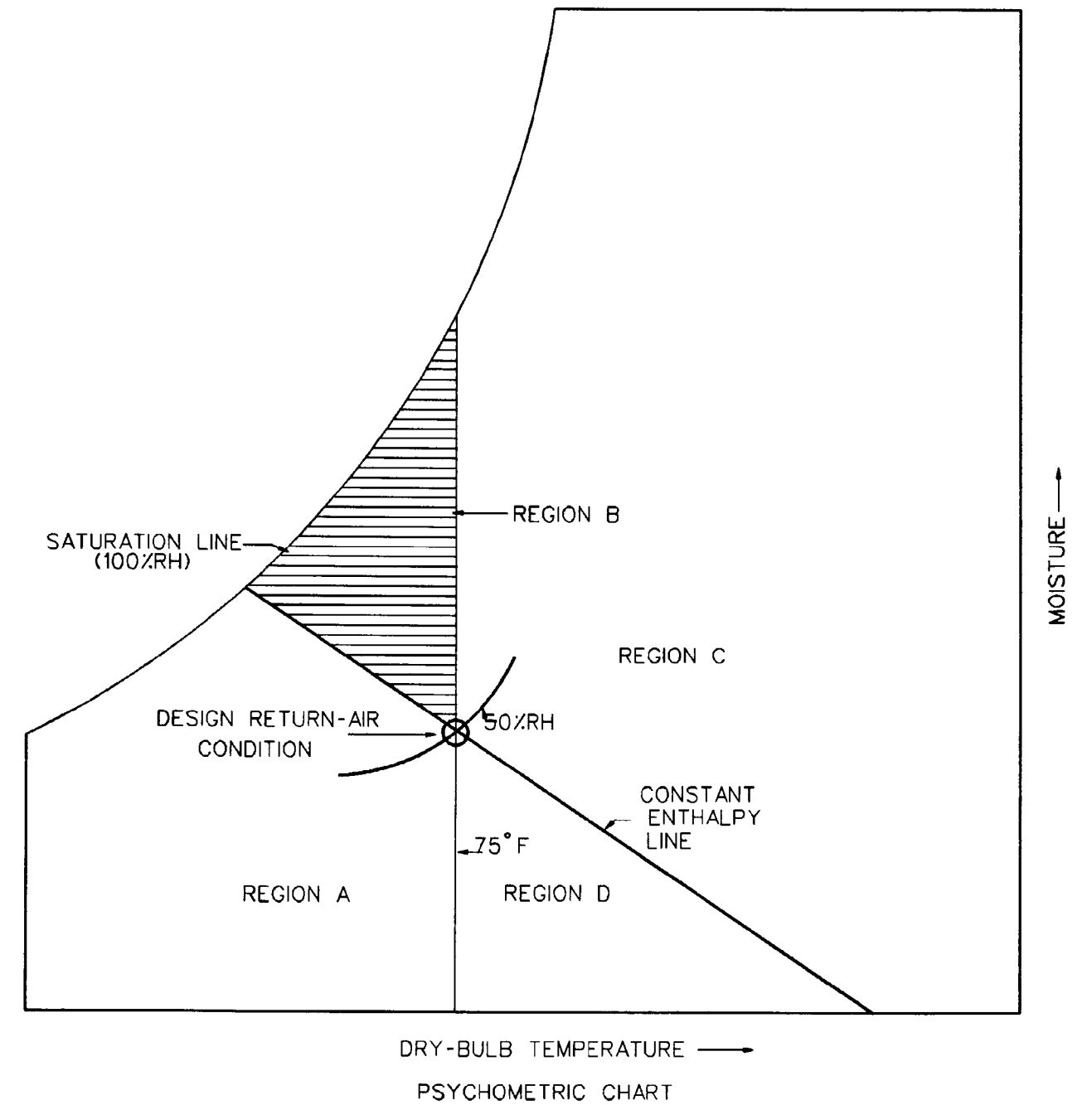


Figure 3-7. Design condition for economized-made operation.

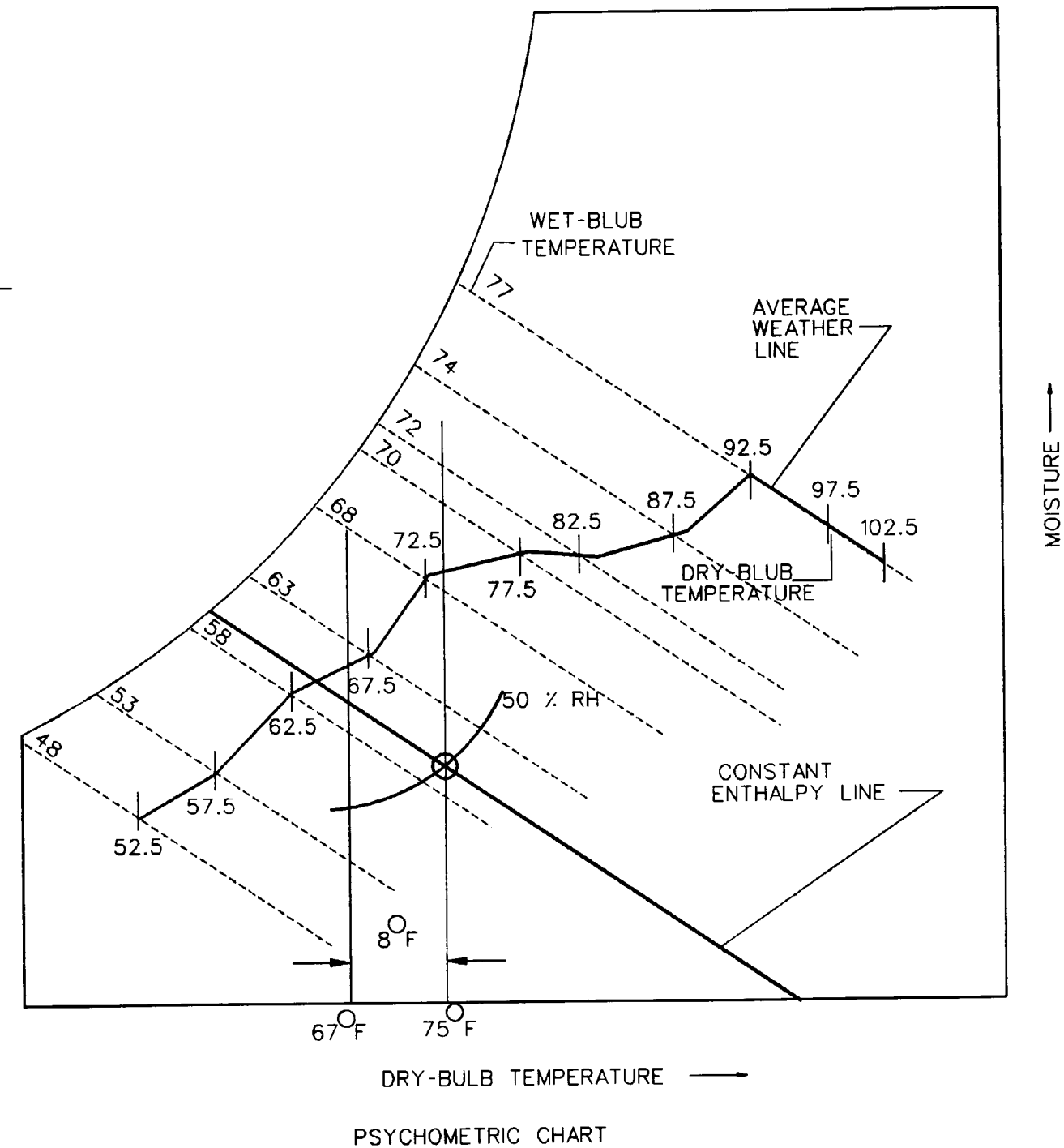
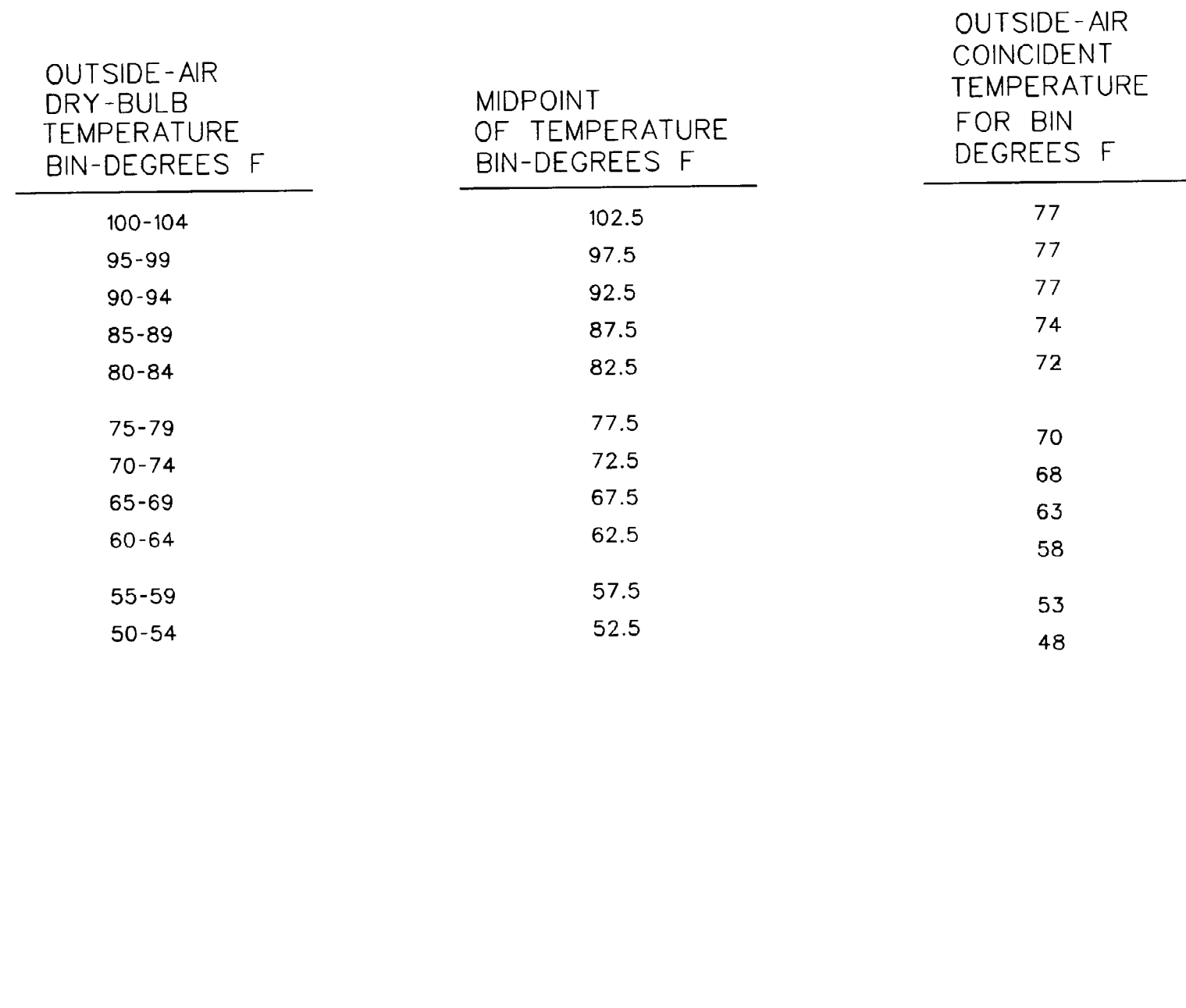


Figure 3-8. Selecting the economized switchover poing.

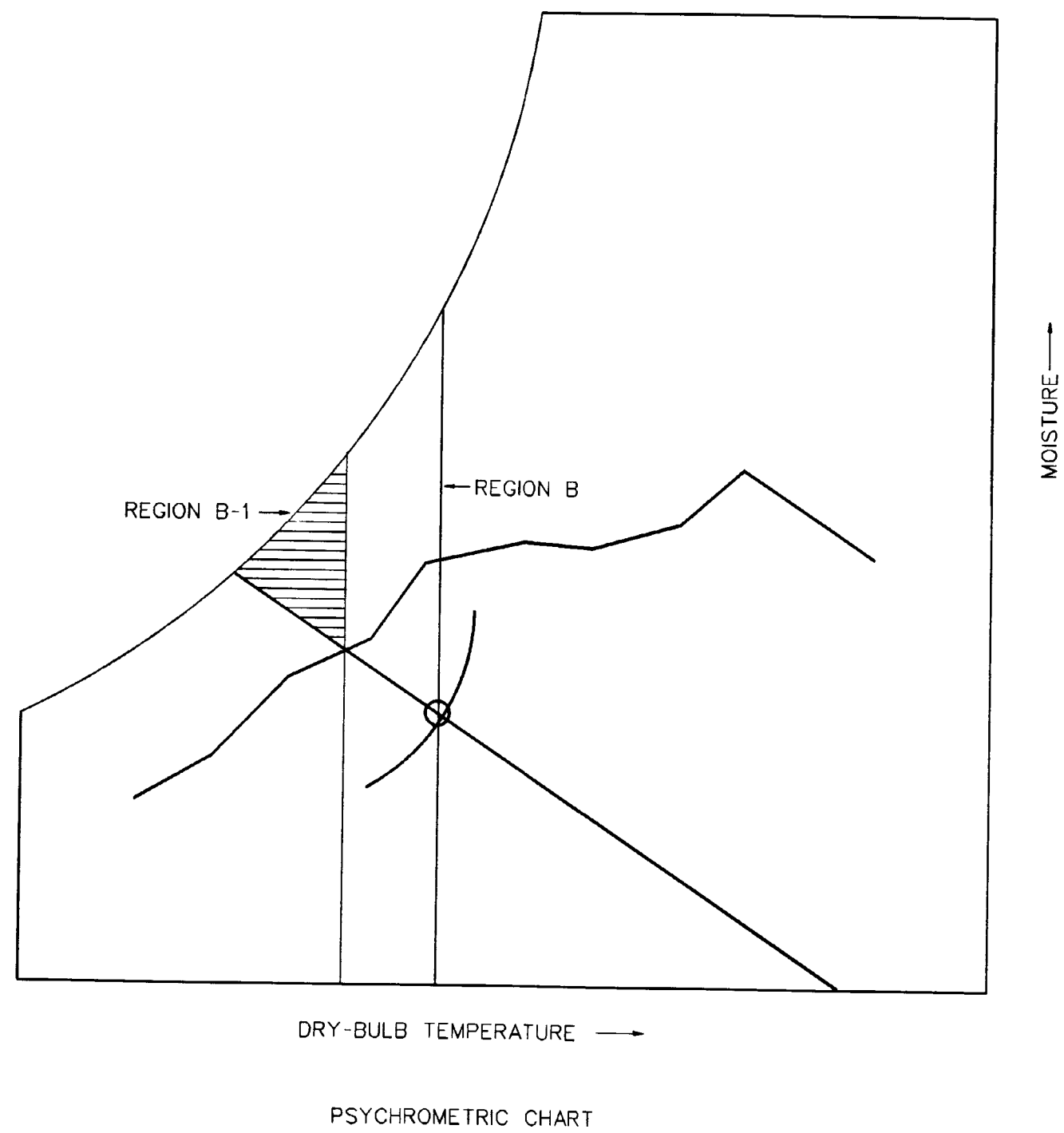


Figure 3-9. Effect on energy conservation of selecting the economized-switchover point.

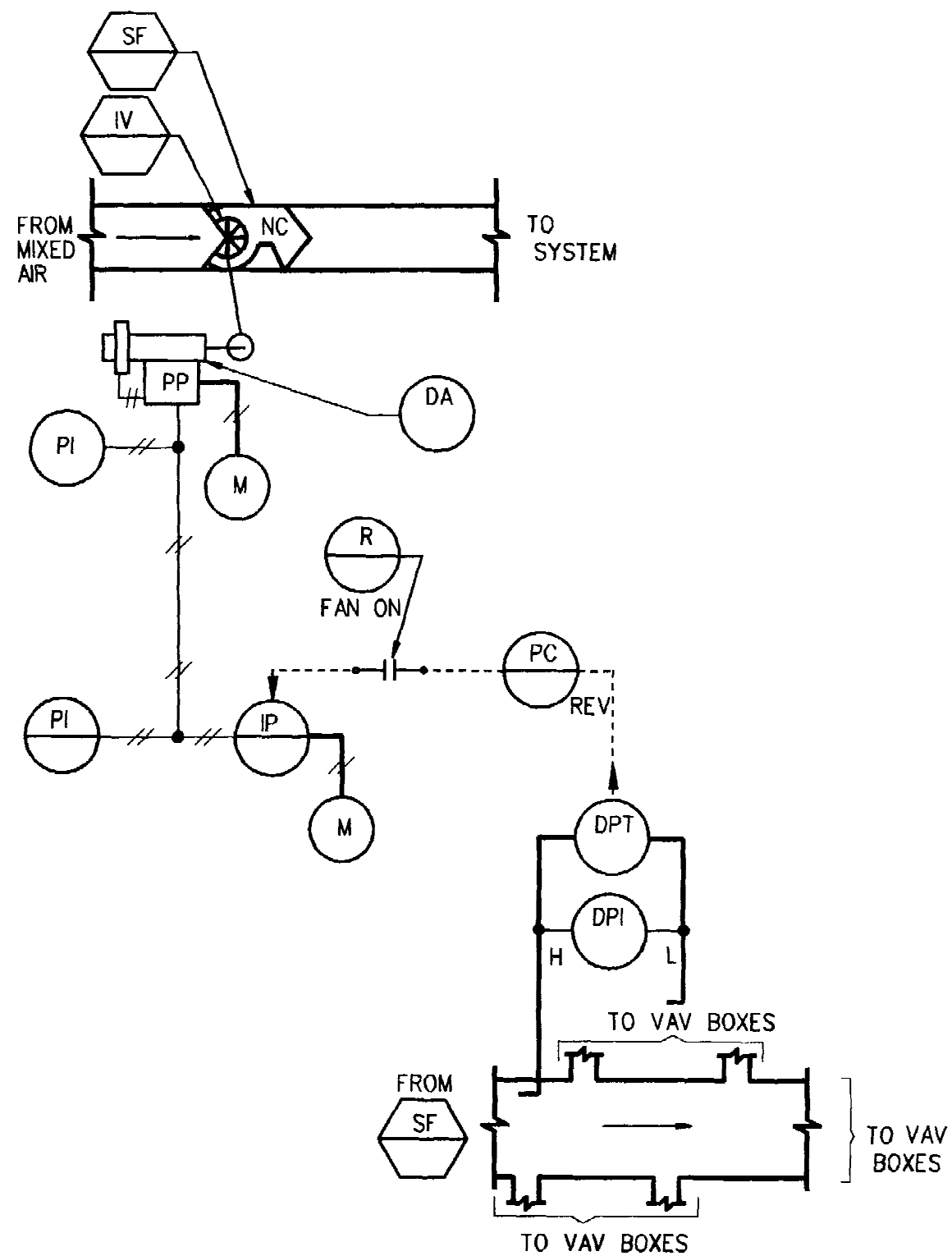


Figure 3-10. Supply-duct static-pressure control loop.

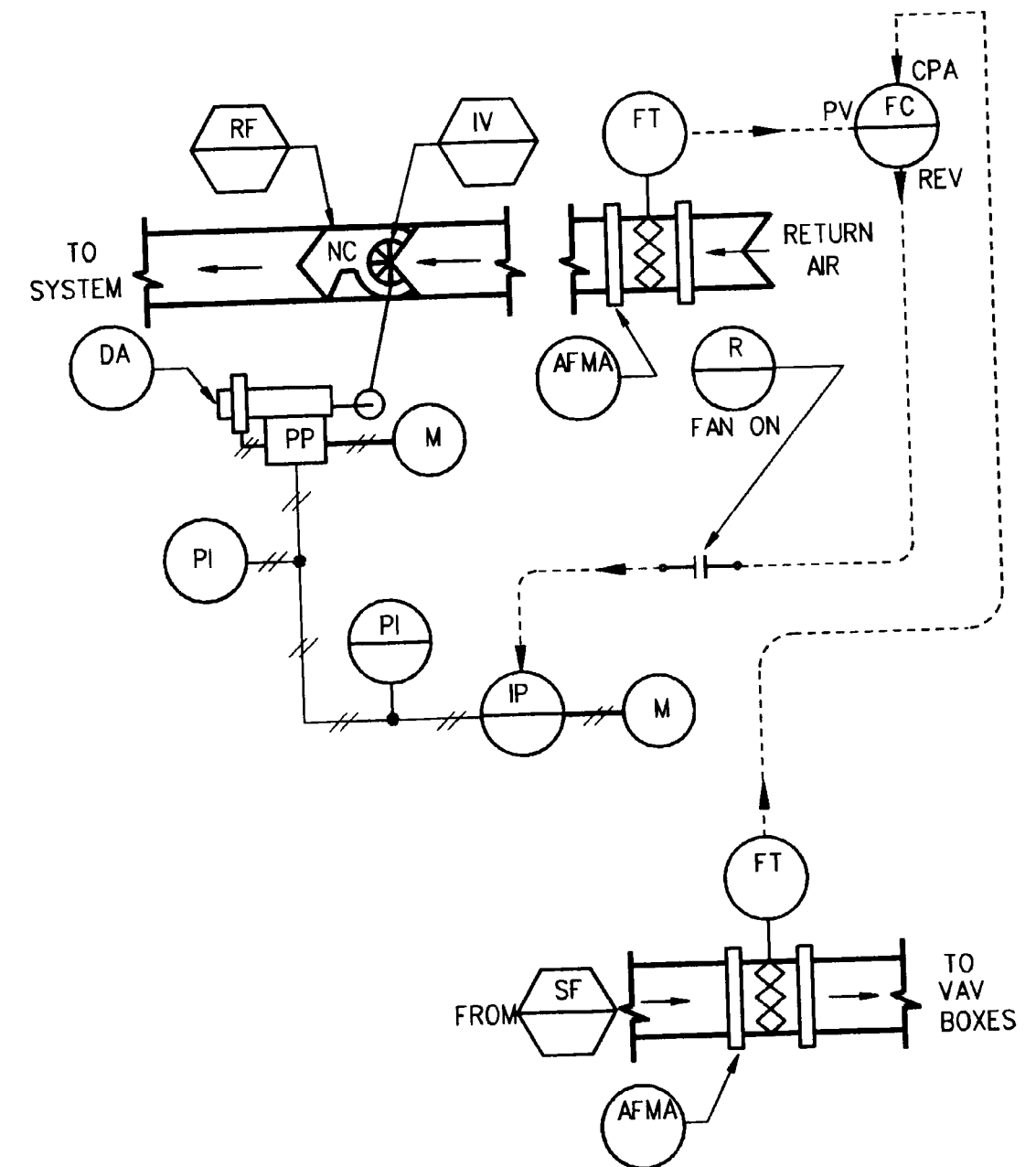


Figure 3-11. Return-fan-volume control loop.



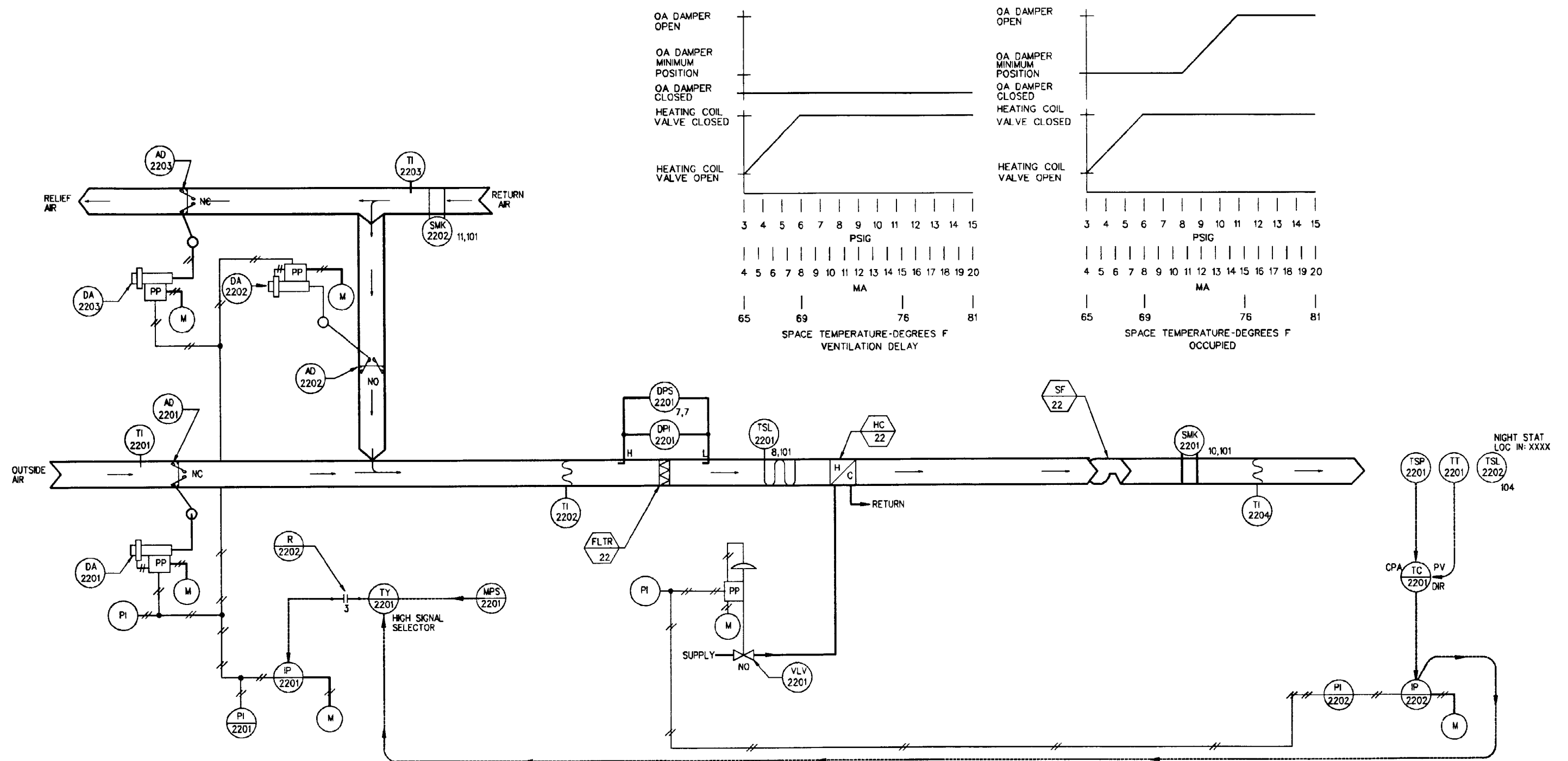
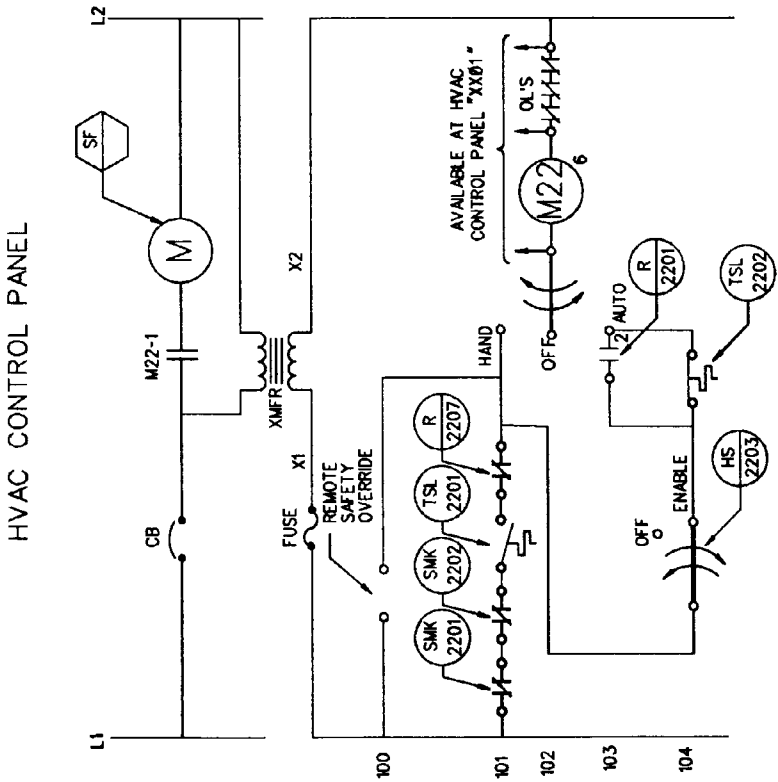
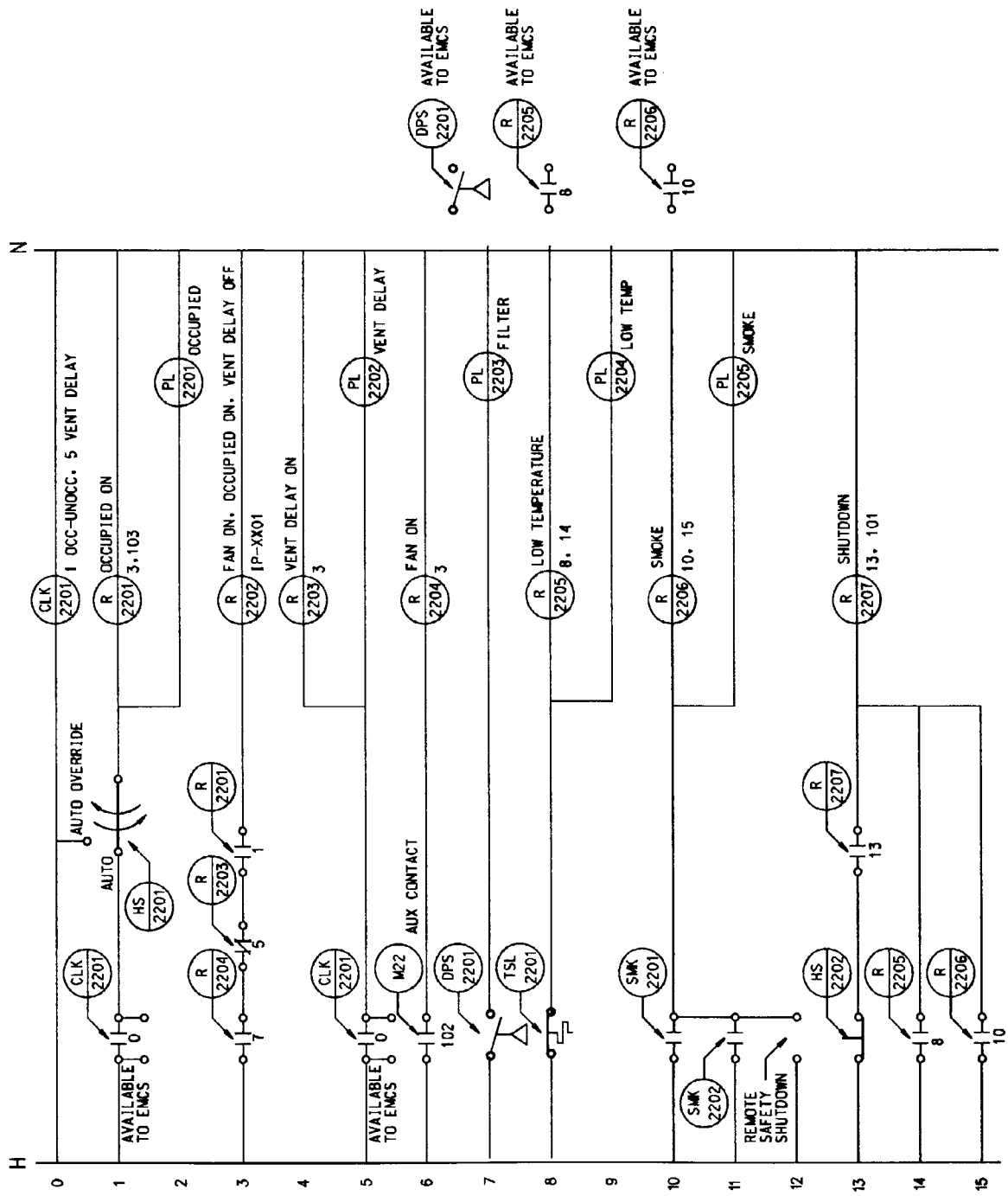


Figure 3-13. Typical schematic.



SUPPLY-FAN STARTER

Figure 3-14. Typical ladder diagram.

LOOP CONTROL FUNCTION	DEVICE NUMBER	DEVICE FUNCTION	SETPOINT	RANGE	ADDITIONAL PARAMETERS
SPACE TEMPERATURE	DA-2201, 02, 03	DAMPER ACTUATOR	—	7-11 PSIG	—
	MPS-2201	MINIMUM-POSITION SWITCH	—	—	SET MIN DA CFM EQUALS 3000 CFM
	TSL-2201	LOW-TEMPERATURE PROTECTION THERMOSTAT	35°F	—	—
	VLV-2201	HEATING-COIL VALVE	—	3-6 PSIG	CV=7 CLOSE AGAINST 20 PSIG
	TC-2201	SPACE-TEMPERATURE CONTROLLER	68°F	50 TO 85°F	SET MAXIMUM LIMITS AVAILABLE TO OCCUPANT BY TSP-2201 AT 68 TO 72°F
	TT-2201	SPACE-TEMPERATURE TRANSMITTER	—	50 TO 85°F	—
SPACE LOW TEMPERATURE	TSL-2202	LOW-LIMIT SPACE-TEMPERATURE THERMOSTAT	55°F	5°F DIFFERENTIAL	CLOSE AT 55°F OPEN AT 60°F
OCCUPIED MODE	CLK-2201 CONTACT	365-DAY SCHEDULE	—	NORMAL SCHEDULE CLOSED: 0705 HRS. OPEN: 1700 HRS M.T.W.TH.F	OPEN: SAT. SUN AND HOLIDAYS
VENTILATION-DELAY MODE	CLK-2201 CONTACT	365-DAY SCHEDULE	—	NORMAL SCHEDULE CLOSED: 0700 HRS. OPEN: 0800 HRS M.T.W.TH.F	

NOTE: OTHER CONTROL DEVICES SUCH AS IPS, RELAYS, AND SIGNAL SELECTORS ARE NOT SHOWN

Figure 3-15. Typical equipment schedule.